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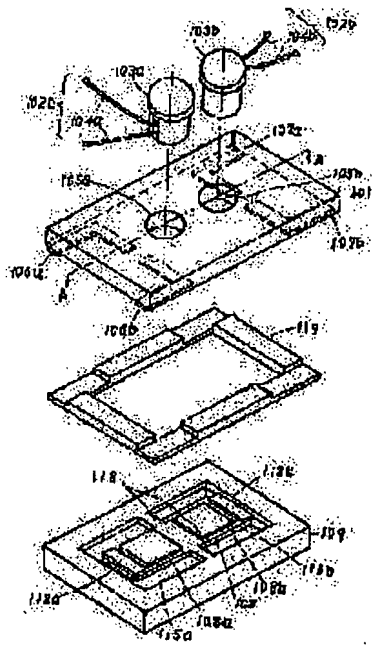
(54) ELECTROMAGNETIC RELAY

(57)Abstract:
PURPOSE: To provide a micro-relay whose driving force is great by making up mechanical elements of an electromagnetic magnet provided for a substrate and of a semi-conductor disposed opposite to the magnet, and concurrently furnishing them with each stationary and each movable contact layer respectively.
CONSTITUTION: There are provided both electromagnetic magnets 102a and 102b which generate magnetic motive force acting as driving source, and sucking sections 115a and 115b made of magnetic substance formed over movable pieces 108a and 108b which are provided for a ceramic substrate 101 supporting the aforesaid magnets via a spacer 119. When DC voltage is applied to the magnets 102a and 102b, the sucking sections 115a and 115b are sucked up while movable pieces 108a and 108b are being deflected by magnet motive force. And stationary contact layers 106a and 106b, 107a and 107b formed in the main surface of a substrate 101, can thereby be opened/closed by means of movable contact layers 112a and 112b separately formed in the aforesaid movable pieces.



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[Patent number]

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* NOTICES *

CLAIMS

[Claim(s)]
[Claim 1] A machine element is constituted from an electromagnetic magnet prepared in the substrate of an electric insulator, and a movable piece which becomes this substrate principal plane that prepared the above-mentioned electromagnetic magnet from the semi-conductor single crystal by which opposite arrangement was carried out through the spacer means, and which carries out movable. The adsorption section formed in the front face of the above-mentioned movable piece which counters the above-mentioned electromagnetic magnet with the magnetic substance, The electromagnetic relay characterized by having the traveling contact layer formed in the above-mentioned movable piece through the insulating thin film, and the stationary-contact layer which are formed in the principal plane of the substrate of the above-mentioned electric insulator, and are opened and closed in the above-mentioned traveling contact layer.
[Claim 2] The electromagnetic relay according to claim 1 characterized by coming to lay a detailed coil underground between the above-mentioned movable piece and the above-mentioned adsorption section.
[Claim 3] The above-mentioned adsorption section is an electromagnetic relay according to claim 1 characterized by being formed using a magnet.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]
[Industrial Application] This invention is one of the micro machines, and relates to the electromagnetic relay which makes magnetomotive force a driving source.
[0002]
[Description of the Prior Art] One of the micro machines has conventionally the electrostatic relay which makes an electrostatic suction force a driving source.
[0003] This electrostatic relay is indicated by JP,2-100224,A as an example. Drawing 14 is the decomposition perspective view of the conventional electrostatic relay. Drawing 15 is the A-A line sectional view of drawing 14 .
[0004] Actuation of this electrostatic relay is explained. If direct current voltage is impressed between the movable piece 911 and the fixed electrode layer 902 by the side of before, an electrostatic suction force will occur between piece section of before movable piece 911 911A, and the above-mentioned electrode layer 902, piece section of before 911A uses the pivotable support section 912 as the supporting point, in order to distort and displace to the electrode layer 902 side, the traveling contact layer 914 will contact the stationary-contact layer 904,905, and between both the stationary-contacts layers 904,905 will be closed. If impression of the above-mentioned direct current voltage is severed, movable piece 911A will return to the original state by the torsion return force of the pivotable support section 912, and between both the stationary-contacts layers 904,905 will be opened wide.
[0005] By impressing direct current voltage between the movable piece 911 and the fixed electrode layer 903 on the backside, piece section of after movable piece 911 911B also performs the same actuation as the above.
[0006] Here, micro processing will become possible if the movable piece 911 is formed from the silicon single crystal wafer 908. Furthermore, since the above-mentioned movable piece 911 was formed from the silicon single crystal wafer 908 of another object in the base 901, by selection of a spacer 909, inter-electrode distance can be changed and desired driving force can be obtained.
[0007]
[Problem(s) to be Solved by the Invention] However, the above-mentioned traveling contact layer 914 contacts the above-mentioned stationary-contact layer 904,905, and it is required of the electrostatic relay by micro processing raised to above-mentioned drawing 14 to make an electrostatic predetermined suction force occur between the counterelectrodes for a drive which constituted between both the stationary-contacts layers 904,905 from an above-mentioned fixed electrode layer 902,903 and an above-mentioned movable piece 911 in order to carry out ON and OFF control. Moreover, since there is a danger of connecting too hastily if this clearance is made small very much, although it is necessary to make small the above-mentioned inter-electrode clearance which counters, it is unproducible in below the magnitude of actual condition specification.
[0008] Then, the purpose of this invention is by making into a driving source magnetomotive force which happens by impressing direct current voltage to an electromagnetic magnet to offer the micro relay with which bigger driving force than the conventional micro relay is obtained.
[0009]
[Means for Solving the Problem] The electromagnetic relay which relates to claim 1 of this invention in order to attain said purpose A machine element is constituted from an electromagnetic magnet prepared in the substrate of an electric insulator, and a movable piece which becomes this substrate principal plane that prepared the above-mentioned electromagnetic magnet from the semi-conductor single crystal by which opposite arrangement was carried out through the spacer means, and which carries out movable. It is characterized by having the adsorption section formed in the front face of the above-mentioned movable piece which counters the above-mentioned electromagnetic magnet with the magnetic substance, the traveling contact layer formed in the above-mentioned movable piece through the insulating thin film, and the stationary-contact layer which are formed in the principal plane of the substrate of the above-mentioned electric insulator, and are opened and closed in the above-mentioned traveling contact layer. The electromagnetic relay concerning claim 2 is characterized by coming

to lay a detailed coil underground between the above-mentioned movable piece and the above-mentioned adsorption section. The electromagnetic relay concerning claim 3 is characterized by having used the magnet for the above-mentioned adsorption section, and being formed in it.
[0010]
[Function] According to the configuration of claim 1 of this invention, the adsorption section formed in the front face of the movable piece which was countered and arranged in the ****** substrate principal plane in the electromagnetic magnet with which the magnetomotive force used as a driving source occurs, and this electromagnetic magnet, and which carries out movable with the magnetic substance is prepared. The above-mentioned movable piece is sagged with the magnetomotive force which happens by impressing direct current voltage to the above-mentioned electromagnetic magnet, and the above-mentioned movable piece is adsorbed at the above-mentioned electromagnetic magnet. Then, the stationary-contact layer formed in the above-mentioned substrate principal plane in the traveling contact layer separately formed in the above-mentioned movable piece can be opened and closed.
[0011] According to the configuration of claim 2 of this invention, a detailed coil is laid underground between the above-mentioned movable piece and the above-mentioned adsorption section by special processing. Although remnant magnetism remains in the above-mentioned adsorption section slightly after impressing and disconnecting direct current voltage to the above-mentioned electromagnetic magnet, direct current voltage can be temporarily impressed to the above-mentioned coil laid under the above-mentioned movable piece, and the remnant magnetism of the above-mentioned adsorption section can be removed.
[0012] According to the configuration of claim 3 of this invention, the above-mentioned adsorption section is formed using a magnet. If direct current voltage is always impressed to the above-mentioned electromagnetic magnet, this electromagnetic magnet can be used as an electromagnet. The polarity (N pole and south pole) of the above-mentioned electromagnetic magnet can be changed by changing the sense of the current passed in the coil of the above-mentioned electromagnetic magnet. Then, a movable piece can be adsorbed or the above-mentioned electromagnetic magnet can be opposed.
[0013]
[Example] One example of this invention is explained with reference to a drawing. Drawing 1 is the decomposition perspective view of an electromagnetic relay of the 1st example. Drawing 2 is the A-A line sectional view of drawing 1 . Drawing 3 is drawing having shown the creation approach of ceramic substrate side 101 gradually, and drawing 4 is the expanded sectional view of electromagnetic magnet 102a made to insert in the through hole of the ceramic substrate 101 of drawing 3 .
[0014] The electromagnetic magnets 102a and 102b consist of Cores 103a and 103b and Coils (copper wire) 104a and 104b. Cores 103a and 103b are created by making for example, a Mn (manganese)-Zn (zinc) ferrite into fine particles, putting into metal mold, hardening, and calcinating, and Coils 104a and 104b roll the about 30-turn surroundings at a time with the 0.1mm copper wire covered with the insulating material around the heart in Cores 103a and 103b, and they create.
[0015] A ceramic substrate 101 is created by putting the fine particles of aluminum 2O3 (alumina) into metal mold, hardening them, and calcinating them. Through holes 105a and 105b are formed in the ceramic substrate 101 (drawing 3 (a)). First, Cr (chromium) and Au(gold) are formed with vacuum deposition all over the Ath page of a ceramic substrate 101. At this time, Cr raises the adhesion of a ceramic substrate 101 and Au, and forms Cr ahead of Au. After forming Au/Cr, the stationary-contact layers 106a, 106b, 107a, and 107b are created by etching (it is described as etching below.) according an Au/Cr layer to a photolithography technique (drawing 3 (b)).
[0016] Drawing 5 is drawing having shown gradually the creation approach by the side of Si (silicon single crystal wafer) substrate which consists of a movable piece 108 of the 1st example. The Si substrate 109 used as the above-mentioned movable piece 108 is created in the direction of a field as shown in drawing 6 . If the above-mentioned Si substrate 109 is manufactured in the shape of a rectangle, although, as for parallel 602a and 602b, a precise

straight line is obtained to orientation FAZETTO (it is described as Following OF.) 601, the perpendicular sides 602c and 602d will become Giza-like to OF601. However, if the above-mentioned Si substrate 109 is manufactured in the slanting direction of a field to the above OF601, the above-mentioned Si substrate 109 of the others shown in drawing 6 which serves as a configuration of the shape of 603a, 603b, 603c, and Giza where 603d is complicated, and requires a precise configuration will be hard to be obtained four sides.

[0017] Then, it manufactures so that four sides of the Si substrate 109 may be set to 602a, 602b, 602c, and 602d, and SiO2(silicon oxide) 110a and 110b are formed for example, by the oxidizing [thermally] method to the Ath page of the Si substrate 109 first shown in drawing 5 , and the Bth page (drawing 5 (a)). After forming SiO2, SiOof Bth above-mentioned page2110b is etched, and removal processing of the perimeter frame is left and carried out (drawing 5 (b)). Specified quantity removal processing of within the limit [perimeter] is carried out for the Si substrate 109 to this Bth page by KOH (potassium hydroxide) anisotropic etching by using SiO2110b as a mask (drawing 5 (c)).

[0018] Next, Cr111 and Au(gold)112 are formed all over the Ath page with vacuum deposition. At this time, Cr raises the adhesion of SiO2 and Au and forms Cu ahead of Au. The traveling contact layers 112a and 112b are formed in the piece of an edge of the part which etches a Cr/Au layer using an aqua regia (hydrochloric acid: nitric acid : 3:1 volume ratios), and serves as the above-mentioned movable pieces 108a and 108b. the whole surface of the Ath page of after that -- the permalloy film 113 (alloy of nickel and iron) -- for example, membranes are formed with vacuum deposition thinly about 300A (drawing 5 (d)). Next, a resist 114 is formed with vacuum deposition on the permalloy film 113 of the whole surface of the Ath above-mentioned page.

[0019] Adsorption **** 116a and 116b are formed for the above-mentioned resist 114 by adhesion exposure with the ********** form of the contact surface of the above-mentioned electromagnetic magnets 102a and 102b. Then, the permalloy film 115 is thickly formed with vacuum deposition equally [about 12 microns] all over the Ath above-mentioned page (drawing 5 (e)).

[0020] In addition, this permalloy film 113,115 is NiSO4.6H2O (nickel sulfate)... It is 150gFeSO4.7H2O (iron sulfate)..... It is 10gH3BO4 (boric acid). ..... 20g saccharin ..... What mixed 0.75g is used.

[0021] Next, adsorption **** 116a and 116b formed by the resist 114 on the Ath above-mentioned page are covered by Resists 117a and 117b, and the permalloy film 113,115 from which a nitric acid, hydrogen peroxide solution, and water serve as outside the limit [of the Ath page / adsorption section] with the etching reagent of 2.9:1:7.2 is etched and removed (drawing 5 (f)). Next, adhesion exposure removes altogether these resists 114,117a and 117b of the Ath page, and the adsorption sections 115a and 115b are formed. And it forms in the form which etched into the configuration where the KO character countered SiOof Ath page2,110a, only the predetermined amount finally etched with a pottasium hydroxide solution, and the movable pieces 108a and 108b connected to the perimeter frame through the pivotable support section 118 (drawing 5 (g)). Si substrate side 109 processed as mentioned above and ceramic substrate side 101 are pasted up through a spacer 119.

[0022] Next, actuation of an electromagnetic relay of the 1st example is explained. If direct current voltage is impressed to coil 104of electromagnetic magnet 102a a, magnetomotive force will occur in this electromagnetic magnet 102a, piece section of before movable piece 108 108a uses the pivotable support section 118 as the supporting point, in order to bend and displace to the electromagnetic magnet 102a side, traveling contact layer 112a will contact the stationary-contact layers 106a and 106b, and between both stationary-contacts layer 106a and 106b will be closed.

[0023] If impression of the above-mentioned direct current voltage is severed, movable piece 108A will return to the original state by the torsion return force of the pivotable support section 118, and between both stationary-contacts layer 106a and 106b will be opened wide. Piece section of after movable piece 108 108b also performs the same actuation as the above by impressing direct current voltage to coil 104of electromagnetic magnet 102b b. Although remnant

magnetism remains in the above-mentioned electromagnetic magnets 102a and 102b slightly at the adsorption sections 115a and 115b after impressing and disconnecting direct current voltage, there is an electromagnetic relay of the 2nd example as a means which removes this.
[0024] Drawing 7 is the important section cross-section decomposition perspective view of an electromagnetic relay of the 2nd example. Drawing 8 is the B-B line sectional view of drawing 7 . Drawing 9 is drawing having shown gradually the creation approach by the side of Si substrate which consists of a movable piece 208. SiO2(silicon oxide) 210a and 210b are first formed by the oxidizing [thermally] method to the Ath page of the Si substrate 209, and the Bth page (drawing 9 (a)). After forming SiO2, SiOof Bth above-mentioned page2210b is etched, and removal processing of the perimeter frame is left and carried out (drawing 9 (b)). Specified quantity removal processing of within the limit [perimeter] is carried out for the Si substrate 209 to this Bth page by KOH (potassium hydroxide) anisotropic etching by using SiO2210b as a mask (drawing 9 (c)).
[0025] Next, the detailed coils 114a and 114b are formed in the Ath page part of the Si substrate 209 which counters the above-mentioned electromagnetic magnets 102a and 102b. the above -- as a processing means of a detailed coil, Nb (niobium) is formed with vacuum deposition all over the Ath page of the 1Si substrate 209.
2) Attach a copper plate 214 to the Ath page part of the Si substrate 209 which counters the above-mentioned electromagnetic magnets 102a and 102b with vacuum deposition after forming Nb. At this time, Nb is used in order to raise SiO2210a and copper plate 214 adhesion.
3) Process this copper plate 214 on a fault volume by etching, and form the detailed coils 214a and 214b, after attaching a copper plate 214.
After forming the detailed coils 214a and 214b, polyimide (resin) 215 is attached all over the Ath page, and the detailed coils 214a and 214b are fixed to the Si substrate 209 (drawing 9 (b)). In order to pull out the piece of an edge of the core of the above-mentioned coils 214a and 214b out of this coil, etching removes the polyimide 215 of the piece part of an edge of the core of the 1 above-mentioned coils 214a and 214b.
2) Form Nb with vacuum deposition all over the Ath page of Si ******.
3) Attach the small copper plates 216a and 216b of two sheets with vacuum deposition in the configuration which processed into the Ath page of the Si substrate 209, and was put on the fixed detailed coils 214a and 214b.
4) And process the above-mentioned copper plates 216a and 216b by etching, and form the piece of an edge which exists at the core of the above-mentioned coils 214a and 214b so that it may become an outgoing line other than this coil.
Special processing is carried out as mentioned above, and outgoing lines 216a and 216b are formed (drawing 9 (e)). After forming outgoing lines 216a and 216b, polyimide 217 is attached all over the Ath page, and outgoing lines 216a and 216b are fixed to the Si substrate 209. Next, only above-mentioned coil 214a and a 214b part leave the above-mentioned polyimide 217 by etching, and it removes. (Drawing 9 (f)) . Next, Cr219 and Au(gold)218 are formed all over the Ath page with vacuum deposition. At this time, Cr raises the adhesion of SiO2 and Au and forms Cu ahead of Au. The traveling contact layers 218a and 218b are formed in the piece of an edge of the part which etches a Cr/Au layer using an aqua regia (hydrochloric acid: nitric acid : 3:1 volume ratios), and serves as the above-mentioned movable pieces 208a and 208b.
[0026] the whole surface of the Ath page of after that -- the permalloy film 220 (alloy of nickel and iron) -- for example, membranes are formed with vacuum deposition thinly about 300A (drawing 9 (g)).
[0027] Next, a resist 221 is formed with vacuum deposition on the entire permalloy film 220 of the Ath above-mentioned page. Adsorption **** 223a and 223b are formed for the above-mentioned resist 221 by adhesion exposure with the ********** form of the contact surface of the above-mentioned electromagnetic magnets 102a and 102b. Then, except for the resist 221 of the Ath above-mentioned page, the permalloy film 222 is thickly formed with vacuum deposition equally [about 12 microns] (drawing 10 (h)).
[0028] In addition, this permalloy film 220,222 is NiSO4.6H2O (nickel sulfate)... It is 150gFeSO4.7H2O (iron sulfate)..... It is 10gH3BO4 (boric acid). ..... 20g saccharin ..... What mixed

0.75g is used.
[0029] Next, the resist 221 of adsorption **** 223a and 223b formed on this Ath page is covered by Resists 224a and 224b, and after that, for example, a nitric acid, hydrogen peroxide solution, and water etch the permalloy film 220,222 of an adsorption section outside the limit of the Ath page with the etching reagent of 2.9:1:7.2, and it removes (drawing 10 (i)).
[0030] Next, adhesion exposure removes altogether these resists 221,224a and 224b of the Ath page, and the adsorption sections 223a and 223b are formed (drawing 10 (j)). And it forms in the form which etched into the configuration where the KO character countered SiOof Ath page2210a, only the predetermined amount finally etched with a pottasium hydroxide solution, and the movable pieces 208a and 208b connected to the perimeter frame through the pivotable support section 225 (drawing 10 (k)). Si substrate side 209 processed as mentioned above is pasted up through ceramic substrate side 101 and a spacer 119.
[0031] Next, actuation of an electromagnetic relay of the 2nd example is explained. If direct current voltage is impressed to coil 104of electromagnetic magnet 102a a, magnetomotive force will occur in this electromagnetic magnet 102a, piece section of before movable piece 208 208a uses the pivotable support section 225 as the supporting point, in order to bend and displace to the electromagnetic magnet 102a side, traveling contact layer 218a will contact the stationary-contact layers 106a and 106b, and between both stationary-contacts layer 106a and 106b will be closed.
[0032] After refusing impression of the above-mentioned direct current voltage for opening between both above-mentioned stationary-contacts layer 106a and 106b, it is required to remove the remnant magnetism which remained in permalloy film 222a used as adsorption section 223of piece section of above front 208a a. Then, after refusing impression of the above-mentioned direct current voltage first, direct current voltage was made to impress to coil 214a laid under the above-mentioned movable piece 208 temporarily, and the remnant magnetism of the above-mentioned adsorption section 223a was removed. Front piece section 208a returns to the original state by the torsion return force of the pivotable support section 225, and between both stationary-contacts layer 106a and 106b is opened wide. By impressing direct current voltage to coil 104of electromagnetic magnet 102b b, piece section of after movable piece 208 208b also performs the same actuation as the above.
[0033] Drawing 11 is the important section cross-section perspective view of an electromagnetic relay of the 3rd example. Drawing 12 is the C-C line sectional view of drawing 11 . Drawing 13 is the expanded sectional view of electromagnetic magnet 302a made to insert in the through hole of the ceramic substrate of drawing 11 . A magnet is attached and formed in the adsorption sections 315a and 315b on the Si substrate 309 which counters the electromagnetic magnets 302a and 302b in this example. In addition, the structure of a part is the same as that of an electromagnetic relay of the 1st example.
[0034] Next, actuation of an electromagnetic relay of the 3rd example is explained.
[0035] If the direct current voltage of a negative electrode (-: minus) is impressed in the direction of A from a positive electrode (+: plus) among drawing to coil 304of electromagnetic magnet 302a of structure of U character mold a Magnetomotive force occurs in this electromagnetic magnet 302a, ****** of electromagnetic magnet 302a countered and arranged in the adsorption section N pole of piece section of before movable piece 308 308a serves as the south pole, and one ****** which was countered and arranged in this adsorption section south pole and which will said electromagnetic magnet 302a Accept it serves as N pole. In order that movable piece 308a may bend and displace the pivotable support section 318 to the electromagnetic magnet 302a side with the attraction between the unlike poles which faced each other as the supporting point, traveling contact layer 312a contacts the stationary-contact layers 306a and 306b, and Kaisei of between both stationary-contacts layer 306a and 306b is carried out.
[0036] The direct current voltage of a negative electrode (-: minus) is impressed to opening between both above-mentioned stationary-contacts layer 306a and 306b from a positive electrode (+: plus) in the direction of B to 304of above-mentioned electromagnetic magnet 302a a. With the above, the magnetomotive force to hard flow is occurred in this electromagnetic

magnet 302a. ****** of electromagnetic magnet 302a arranged to the adsorption section N pole of piece section of before movable piece 308 308a serves as N pole, and this adsorption section south pole is countered. One arranged ****** which will said electromagnetic magnet 302a Accept it serves as the south pole, movable piece 308a separates from electromagnetic magnet 302a according to the repulsive force between the unlike poles which faced each other considering the pivotable support section 318 as the supporting point, and both the stationary-contacts layers 306a and 306b are opened wide. Piece section of after movable piece 308 308b also performs the same actuation as the above by impressing direct current voltage to coil 304of electromagnetic magnet 302b b to compensate for actuation of a relay. The electromagnetic magnets 102a and 102b inserted in the through holes 105a and 105b of the ceramic substrate 101 shown in drawing 1 in the 3rd example are made to counter, and actuation with the same said of the configuration of one adsorption section of N pole or the south pole is considered in the magnet of the adsorption sections 315a and 315b on the Si substrate 309.
[0037]
[Effect of the Invention] Since he is trying to use magnetomotive force as a driving source moreover, while being able to obtain big driving force as compared with the former taking advantage of the description of the conventional micro relay according to this invention, contact force becomes large and the stability of a relay can increase.

[Translation done.]

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the decomposition perspective view of an electromagnetic relay of the 1st example.
[Drawing 2] It is the A-A line sectional view of drawing 1 .
[Drawing 3] It is drawing having shown gradually the creation approach by the side of a ceramic substrate.
[Drawing 4] It is the expanded sectional view of the electromagnetic magnet made to insert in the through hole by the side of the ceramic substrate of drawing 3 .
[Drawing 5] It is drawing having shown gradually the creation approach by the side of Si (silicon single crystal wafer) substrate which consists of a movable piece of the 1st example.
[Drawing 6] It is the explanatory view of the direction of a field of a silicon single crystal wafer.
[Drawing 7] It is the decomposition perspective view of an electromagnetic relay of the 2nd example.
[Drawing 8] It is the B-B line sectional view of drawing 7 .
[Drawing 9] It is drawing having shown gradually the creation approach (a-g) by the side of Si (silicon single crystal wafer) substrate which consists of a movable piece of the 2nd example.
[Drawing 10] It is drawing having shown gradually the creation approach (h-k) by the side of Si (silicon single crystal wafer) substrate which consists of a movable piece of the 2nd example.
[Drawing 11] It is the important section cross-section perspective view of an electromagnetic

relay of the 3rd example.
[Drawing 12] It is the C-C line sectional view of drawing 11 .
[Drawing 13] It is the expanded sectional view of the electromagnetic magnet made to insert in the through hole by the side of the ceramic substrate of drawing 11 .
[Drawing 14] It is the decomposition perspective view of the electrostatic relay in which conventional micro Massine's example is shown.
[Drawing 15] It is the A-A line sectional view of drawing 14 .
[Description of Notations]
101 Ceramic Substrate
102a, 102b Electromagnetic magnet
103a, 103b Core
104a, 104b Coil (copper wire)
105a, 105b Through hole
106a, 106b Stationary-contact layer
107a, 107b Stationary-contact layer
108a, 108b Movable piece
109 Si Substrate
110a, 110b SiO2 (silicon oxide)
112a, 112b Traveling contact layer
115a, 115b Adsorption section (magnetic substance)
118 Pivotable Support Section
119 Spacer

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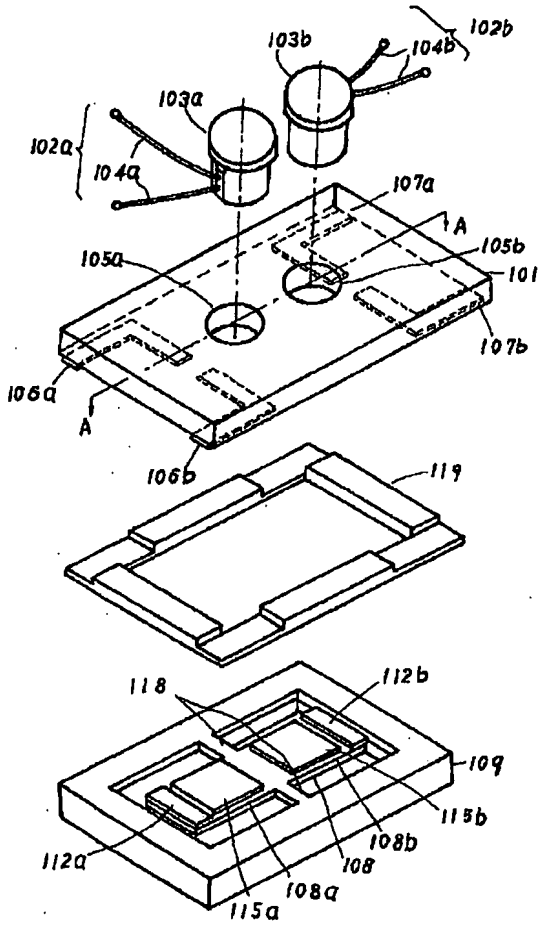
DRAWINGS

[Drawing 1]



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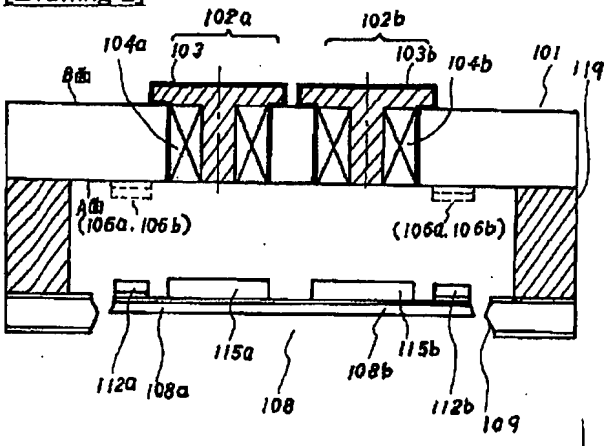

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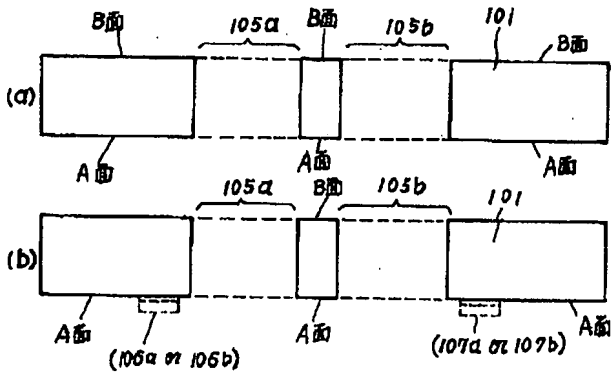

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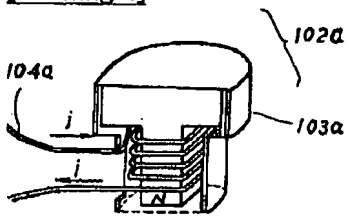

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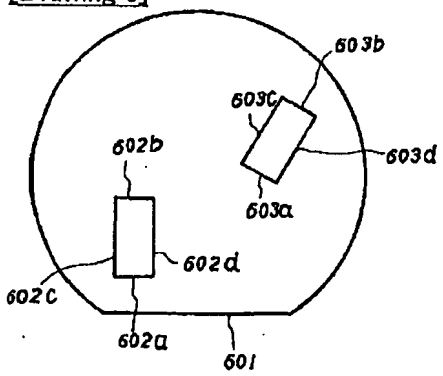
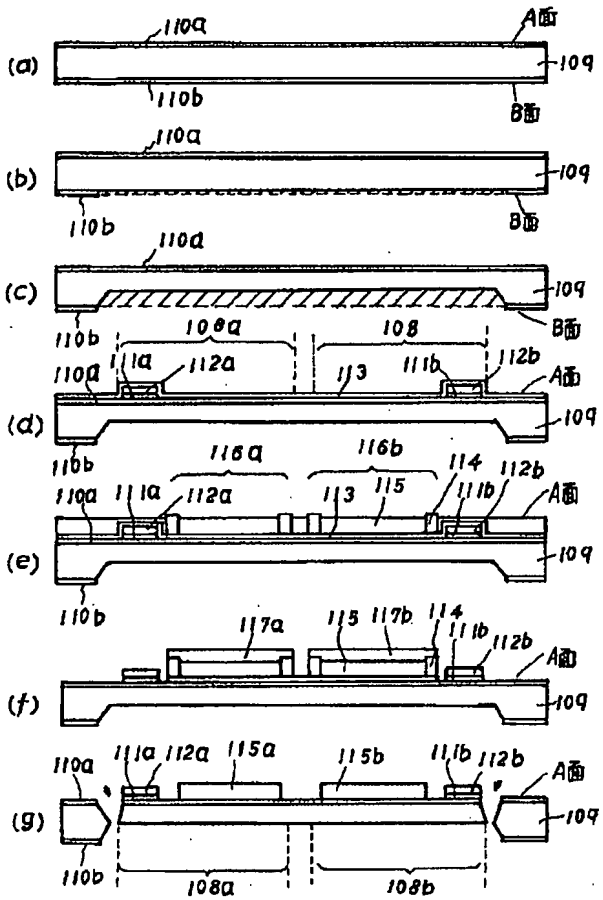


[Drawing 5]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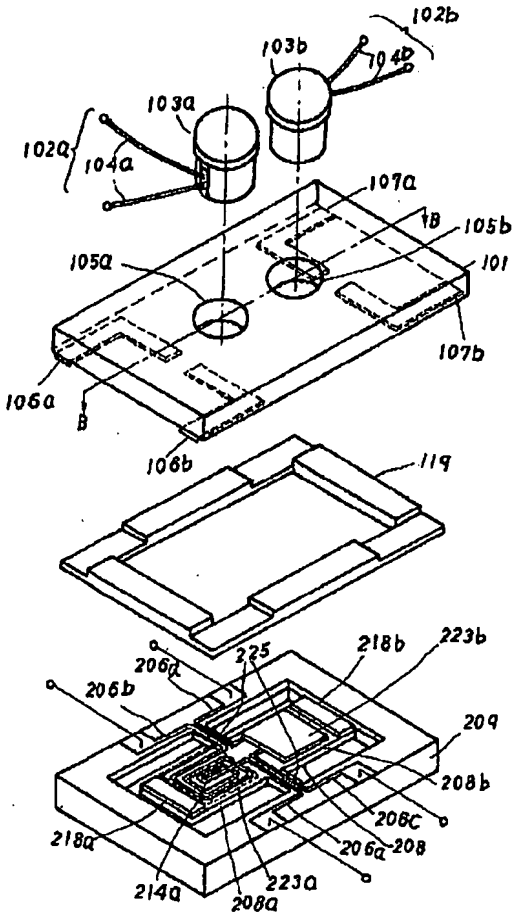
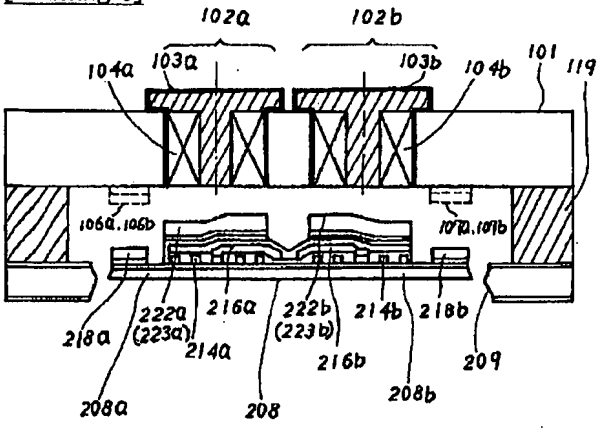
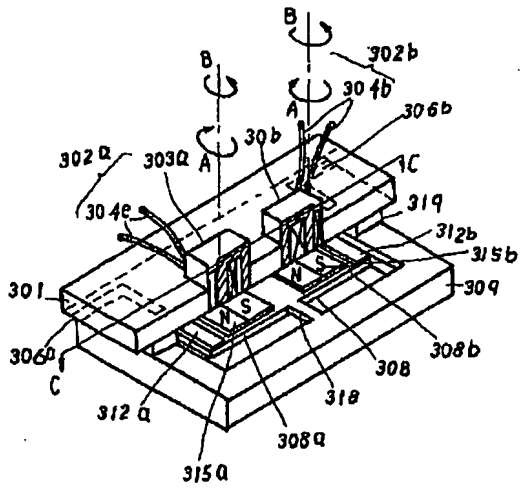
[Drawing 7]



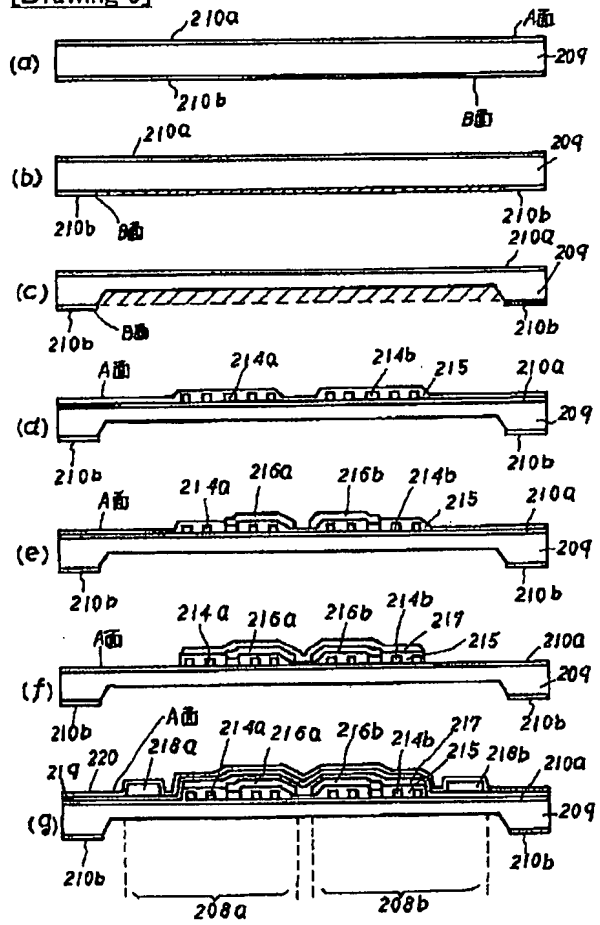
[Drawing 8]



[Drawing 11]



[Drawing 9]



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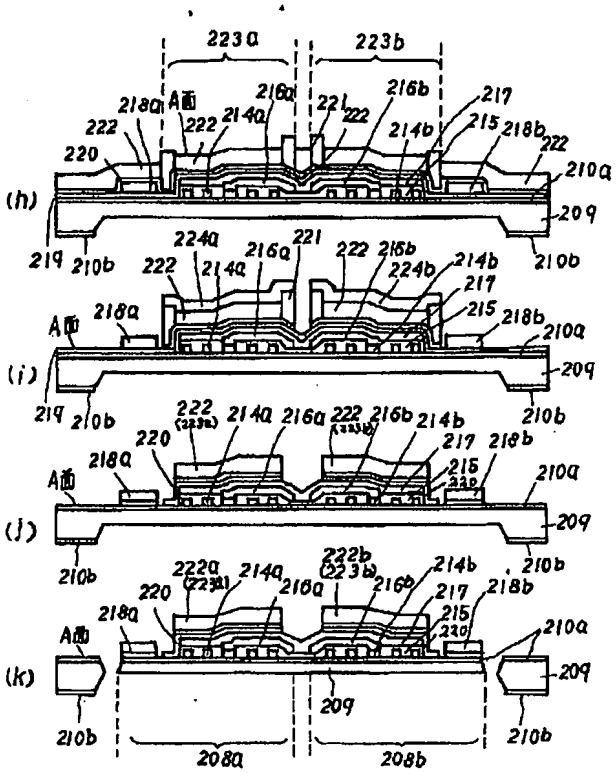
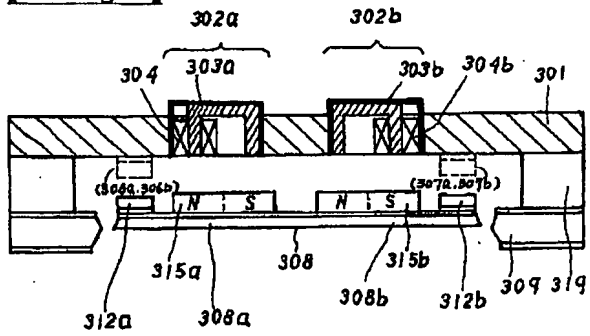


[Drawing 12]



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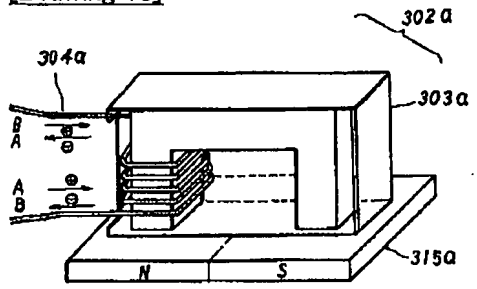

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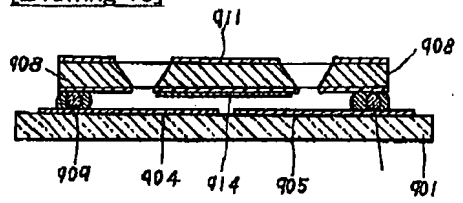

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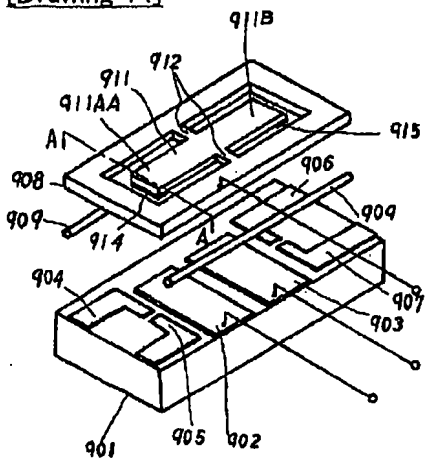

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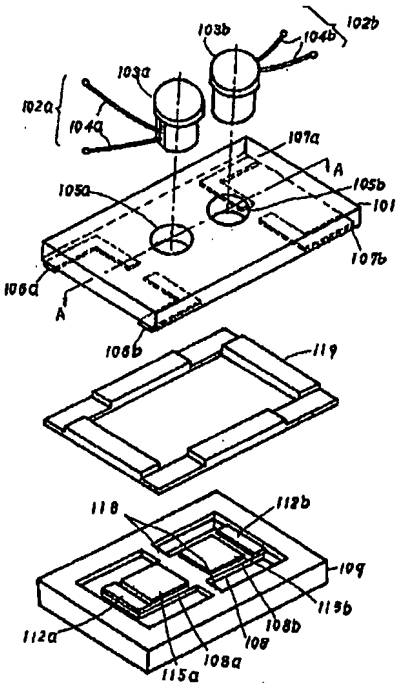
最終頁に続く

(54)【発明の名称】　電磁式リレー

(57)【要約】

【目的】　電磁式マグネットに直流電圧を印加することで起こる起磁力を駆動源とすることにより、従来のマイクロリレーよりも大きな駆動力の得られるマイクロリレーを提供することにある。

【構成】　電気絶縁体の基板に設けた電磁式マグネットと、上記電磁式マグネットを設けたこの基板主面にスペーサ手段を介して対向配設された可動する半導体単結晶からなる可動片とで機械要素を構成し、上記電磁式マグネットに対向する上記可動片の表面に磁性体で形成された吸着部と、上記可動片に絶縁薄膜を介して形成された可動接点層と、上記電気絶縁体の基板の主面に形成されて上記可動接点層で開閉される固定接点層とを備えたことを特徴とする電磁式リレー。



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【特許請求の範囲】

【請求項１】　電気絶縁体の基板に設けた電磁式マグネットと、上記電磁式マグネットを設けたこの基板主面にスペーサ手段を介して対向配設された可動する半導体単結晶からなる可動片とで機械要素を構成し、

上記電磁式マグネットに対向する上記可動片の表面に磁性体で形成された吸着部と、

上記可動片に絶縁薄膜を介して形成された可動接点層と、上記電気絶縁体の基板の主面に形成されて上記可動接点層で開閉される固定接点層とを備えたことを特徴とする電磁式リレー。

【請求項２】　上記可動片と上記吸着部との間に微細なコイルを埋設してなることを特徴とする請求項１記載の電磁式リレー。

【請求項３】　上記吸着部は、磁石を用いて形成されたことを特徴とする請求項１記載の電磁式リレー。

【発明の詳細な説明】

【０００１】

【産業上の利用分野】この発明はマイクロマシーンの１つであり、起磁力を駆動源とする電磁式リレーに関する。

【０００２】

【従来の技術】従来マイクロマシーンの１つに静電吸引力を駆動源とする静電式リレーがある。

【０００３】この静電式リレーは一例として特開平２－１００２２４号に開示されている。図１４は従来の静電式リレーの分解斜視図である。図１５は図１４のＡ－Ａ線断面図である。

【０００４】この静電式リレーの動作について説明する。可動片９１１と前側の固定電極層９０２との間に直流電圧を印加すると、可動片９１１の前片部９１１Ａと上記電極層９０２との間に静電吸引力が生起し、前片部９１１Ａは枢支部９１２を支点として電極層９０２側へ歪んで変位するため、可動接点層９１４が固定接点層９０４，９０５に接触し、両固定接点層９０４，９０５間が閉成される。上記直流電圧の印加を断つと、可動片９１１Ａは枢支部９１２のねじれ復帰力で原状に復帰し、両固定接点層９０４，９０５間が開放される。

【０００５】可動片９１１と後側の固定電極層９０３との間に直流電圧を印加することにより、可動片９１１の後片部９１１Ｂも上記と同様の動作を行なう。

【０００６】ここで、可動片９１１をシリコン単結晶ウエハ９０８から形成すれば微細加工が可能となる。さらに、上記可動片９１１を基体９０１とは別体のシリコン単結晶ウエハ９０８から形成したから、スペーサ９０９の選択によって電極間距離を変えて所望の駆動力を得ることができる。

【０００７】

【発明が解決しようとする課題】しかしながら、上記図１４に上げた微細加工による静電式リレーでは上記可動

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接点層９１４が上記固定接点層９０４，９０５に接触し、両固定接点層９０４，９０５間をＯＮ，ＯＦＦ制御をするために上記固定電極層９０２，９０３と上記可動片９１１とで構成した駆動用対向電極間に所定の静電吸引力を生起させることが必要である。また、対向する上記電極間の隙間を小さくする必要があるが非常にこの隙間を小さくすると短絡する危険性があるため、実状特定の大きさ以下には作製できない。

【０００８】そこで本発明の目的は電磁式マグネットに直流電圧を印加することで起こる起磁力を駆動源とすることにより、従来のマイクロリレーよりも大きな駆動力の得られるマイクロリレーを提供することにある。

【０００９】

【課題を解決するための手段】前記目的を達成するために本発明の請求項１に係る電磁式リレーは、電気絶縁体の基板に設けた電磁式マグネットと、上記電磁式マグネットを設けたこの基板主面にスペーサ手段を介して対向配設された可動する半導体単結晶からなる可動片とで機械要素を構成し、上記電磁式マグネットに対向する上記可動片の表面に磁性体で形成された吸着部と、上記可動片に絶縁薄膜を介して形成された可動接点層と、上記電気絶縁体の基板の主面に形成されて上記可動接点層で開閉される固定接点層とを備えたことを特徴としている。請求項２に係る電磁式リレーは、上記可動片と上記吸着部との間に微細なコイルを埋設してなることを特徴としている。請求項３に係る電磁式リレーは、上記吸着部に磁石を用いて形成されたことを特徴としている。

【００１０】

【作用】本発明の請求項１の構成によれば駆動源となる起磁力が生起する電磁式マグネットとこの電磁式マグネットを設えた基板主面に対向して配設された可動する可動片の表面に磁性体で形成された吸着部を設ける。上記電磁式マグネットに直流電圧を印加することで起こる起磁力を持って上記可動片を撓ませ、上記電磁式マグネットに上記可動片を吸着する。すると、上記可動片に別途形成された可動接点層で上記基板主面に形成された固定接点層を開閉することができる。

【００１１】本発明の請求項２の構成によれば特殊加工により上記可動片と上記吸着部との間に微細なコイルを埋設する。上記電磁式マグネットに直流電圧を印加、切断した後わずかに上記吸着部に残留磁気が残るが、上記可動片に埋設された上記コイルに直流電圧を、一時的に印加して上記吸着部の残留磁気を取り除くことができる。

【００１２】本発明の請求項３の構成によれば上記吸着部は磁石を用いて形成する。常に上記電磁式マグネットに直流電圧を印加しておけばこの電磁式マグネットは電磁石として使える。上記電磁式マグネットのコイルに流す電流の向きを変えることによって上記電磁式マグネットの極性（Ｎ極・Ｓ極）を切り替えることができる。す

ると、上記電磁式マグネットに可動片を吸着したり、反発したりすることができる。

【００１３】

【実施例】本発明の一実施例を図面を参照して説明する。図１は第１の実施例の電磁式リレーの分解斜視図である。図２は図１のＡ－Ａ線断面図である。図３はセラミック基板側１０１の作成方法を段階的に示した図であり、図４は図３のセラミック基板１０１の貫通穴に挿設させた電磁式マグネット１０２ａの拡大断面図である。

【００１４】電磁式マグネット１０２ａ，１０２ｂはコア１０３ａ，１０３ｂとコイル（銅線）１０４ａ，１０４ｂから成っている。コア１０３ａ，１０３ｂは例えばＭｎ（マンガン）－Ｚｎ（ジンク）フェライトを粉体にして金型に入れて固め、焼成することによって作成し、コイル１０４ａ，１０４ｂはコア１０３ａ，１０３ｂの中の芯のまわりに例えば周りを絶縁物で被覆された０．１ｍｍの銅線により約３０ターンずつ巻いて作成する。

【００１５】セラミック基板１０１は例えばAl_2O_3（アルミナ）の粉体を金型に入れて固め焼成することによって作成する。セラミック基板１０１には、貫通穴１０５ａ，１０５ｂが設けられている（図３（ａ））。まず、セラミック基板１０１のＡ面の全面にＣｒ（クロム）とＡｕ（金）を真空蒸着により成膜する。このときＣｒはセラミック基板１０１とＡｕの密着性を向上させるものでＡｕより先にＣｒを成膜する。Ａｕ／Ｃｒを成膜した後、Ａｕ／Ｃｒ層をフォトリソグラフィー技術によるエッチング（以下エッチングと記す。）により固定接点層１０６ａ，１０６ｂ，１０７ａ，１０７ｂを作成する（図３（ｂ））。

【００１６】図５は第１の実施例の可動片１０８からなるＳｉ（シリコン単結晶ウエハ）基板側の作成方法を段階的に示した図である。上記可動片１０８となるＳｉ基板１０９は例えば図６に示すような面方向に作成する。上記Ｓｉ基板１０９を矩形状に製作すると、オリエンテーション・ファゼット（以下ＯＦと記す。）６０１に対して平行な６０２ａ，６０２ｂは、精密な直線が得られるもののＯＦ６０１に対して垂直な辺６０２ｃ，６０２ｄはギザ状となる。しかし、上記ＯＦ６０１に対して斜めの面方向に上記Ｓｉ基板１０９を製作すると図６に示す他の４辺６０３ａ，６０３ｂ，６０３ｃ，６０３ｄは複雑なギザ状の形状となり、精密な形状を要求する上記Ｓｉ基板１０９は得られにくい。

【００１７】そこでＳｉ基板１０９の４辺が６０２ａ，６０２ｂ，６０２ｃ，６０２ｄとなるように製作して、まず図５に示すＳｉ基板１０９のＡ面及びＢ面に例えば熱酸化法によりSiO_2（酸化シリコン）１１０ａ，１１０ｂを成膜する（図５（ａ））。SiO_2を形成した後、上記Ｂ面の$SiO_2$１１０ｂをエッチングし、周囲枠を残して除去加工する（図５（ｂ））。このＢ面に$SiO_2$１１０ｂをマスクとしてＳｉ基板１０９をＫＯＨ

（水酸化カリウム）異方性エッチングにより周囲枠内を所定量除去加工する（図５（ｃ））。

【００１８】次にＣｒ１１１とＡｕ（金）１１２を真空蒸着によりＡ面の全面に成膜する。この時、ＣｒはSiO_2とＡｕとの密着性を向上させるものでＡｕより先にＣｕを成膜する。Ｃｒ／Ａｕ層を例えば王水（塩酸：硝酸：３：１の容積比）を用いてエッチングして上記可動片１０８ａ，１０８ｂとなる部分の端片に可動接点層１１２ａ，１１２ｂを形成する。その後Ａ面の全面にパーマロイ膜１１３（ニッケルと鉄の合金）を例えば３００オングストローム程薄く真空蒸着により成膜する（図５（ｄ））。次に上記Ａ面の全面のパーマロイ膜１１３に真空蒸着によりレジスト１１４を成膜する。

【００１９】上記レジスト１１４を密着露光により上記電磁式マグネット１０２ａ，１０２ｂの接触面のふちどった形で吸着部枠１１６ａ，１１６ｂを形成する。その後、上記Ａ面の全面に厚くパーマロイ膜１１５を例えば１２ミクロン程度均等に真空蒸着により成膜する（図５（ｅ））。

【００２０】尚、このパーマロイ膜１１３，１１５は例えば

$NiSO_4 \cdot 6H_2O$（硫酸ニッケル）・・・１５０ｇ
$FeSO_4 \cdot 7H_2O$（硫酸鉄）・・・・・・・１０ｇ
H_3BO_4（硼酸）・・・・・・・２０ｇ
サッカリン・・・・・０．７５ｇ

を混合したものを用いる。

【００２１】次に上記Ａ面上のレジスト１１４で形成された吸着部枠１１６ａ，１１６ｂをレジスト１１７ａ，１１７ｂで覆い、そして、例えば硝酸，過酸化水素水，水が２．９：１：７．２のエッチング液によりＡ面の吸着部枠外となるパーマロイ膜１１３，１１５をエッチングして除去する（図５（ｆ））。次にこのＡ面のレジスト１１４，１１７ａ，１１７ｂを密着露光によりすべて除去して、吸着部１１５ａ，１１５ｂを形成する。そしてＡ面のSiO_2，１１０ａにコ字が対向した形状にエッチングを行ない、最後に例えば水酸化カリウム溶液により所定の量だけエッチングを行なって可動片１０８ａ，１０８ｂが枢支部１１８を介して周囲枠に接続した形に形成する（図５（ｇ））。上記のように加工されたＳｉ基板側１０９とセラミック基板側１０１とはスペーサ１１９を介し接着する。

【００２２】次に第１の実施例の電磁式リレーの動作について説明する。電磁式マグネット１０２ａのコイル１０４ａに直流電圧を印加すると、この電磁式マグネット１０２ａに起磁力が生起し、可動片１０８の前片部１０８ａは枢支部１１８を支点として電磁式マグネット１０２ａ側へ撓んで変位するため、可動接点層１１２ａが固定接点層１０６ａ，１０６ｂに接触し両固定接点層１０６ａ，１０６ｂ間が閉成される。

【００２３】上記直流電圧の印加を断つと、可動片１０

８Ａは枢支部１１８のねじれ復帰力で原状に復帰し、両固定接点層１０６ａ，１０６ｂ間が開放される。電磁式マグネット１０２ｂのコイル１０４ｂに直流電圧を印加することにより可動片１０８の後片部１０８ｂも上記と同様の動作を行う。上記電磁式マグネット１０２ａ，１０２ｂに直流電圧を印加・切断した後、わずかに吸着部１１５ａ，１１５ｂに残留磁気が残るが、これを取り除く手段として第２の実施例の電磁式リレーがある。

【００２４】図７は第２の実施例の電磁式リレーの要部断面分解斜視図である。図８は図７のＢ－Ｂ線断面図である。図９は可動片２０８からなるＳｉ基板側の作成方法を段階的に示した図である。まずＳｉ基板２０９のＡ面及びＢ面に熱酸化法によりＳｉO_2（酸化シリコン）２１０ａ，２１０ｂを成膜する（図９（ａ））。ＳｉO_2を形成した後、上記Ｂ面のＳｉ$O_2$２１０ｂをエッチングし、周囲枠を残して除去加工する（図９（ｂ））。このＢ面にＳｉ$O_2$２１０ｂをマスクとしてＳｉ基板２０９をＫＯＨ（水酸化カリウム）異方性エッチングにより周囲枠内を所定量除去加工する（図９（ｃ））。

【００２５】次に上記電磁式マグネット１０２ａ，１０２ｂに対向するＳｉ基板２０９のＡ面部位に微細なコイル１１４ａ，１１４ｂを形成する。上記微細なコイルの加工手段としては、

１）Ｓｉ基板２０９のＡ面の全面にＮｂ（ニオブ）を真空蒸着により成膜する。

２）Ｎｂを成膜した後、上記電磁式マグネット１０２ａ，１０２ｂに対向するＳｉ基板２０９のＡ面部位に銅板２１４を真空蒸着により付ける。この時ＮｂはＳｉ$O_2$２１０ａと銅板２１４密着性を向上させるために用いる。

３）銅板２１４を付けた後、この銅板２１４をエッチングにより過巻き上に加工して微細なコイル２１４ａ，２１４ｂを形成する。

微細なコイル２１４ａ，２１４ｂを形成した後、Ａ面の全面にポリイミド（樹脂）２１５を付けＳｉ基板２０９に微細なコイル２１４ａ，２１４ｂを固定する（図９（ｂ））。上記コイル２１４ａ，２１４ｂの中心の端片を同コイルの外へ引き出すためには、

１）上記コイル２１４ａ，２１４ｂの中心の端片部位のポリイミド２１５をエッチングにより除去する。

２）Ｓｉ基板りＡ面の全面にＮｂを真空蒸着により成膜する。

３）Ｓｉ基板２０９のＡ面に加工し、固定した微細コイル２１４ａ，２１４ｂに重ねた形状で２枚の小さな銅板２１６ａ，２１６ｂを真空蒸着により付ける。

４）そして上記コイル２１４ａ，２１４ｂの中心にある端片を同コイルの外への引き出し線となるように上記銅板２１６ａ，２１６ｂをエッチングにより加工して形成する。

以上のように特殊加工して引き出し線２１６ａ，２１６ｂを形成する（図９（ｅ））。引き出し線２１６ａ，２１６ｂを形成した後、Ａ面の全面にポリイミド２１７を付けＳｉ基板２０９に引き出し線２１６ａ，２１６ｂを固定する。次にエッチングにより上記ポリイミド２１７を上記コイル２１４ａ，２１４ｂ部位のみ残して除去する。（図９（ｆ））。次にＣｒ２１９とＡｕ（金）２１８を真空蒸着によりＡ面の全面に成膜する。この時、ＣｒはＳｉO_2とＡｕとの密着性を向上させるものでＡｕより先にＣｕを成膜する。Ｃｒ／Ａｕ層を例えば王水（塩酸：硝酸：３：１の容積比）を用いてエッチングして上記可動片２０８ａ，２０８ｂとなる部分の端片に可動接点層２１８ａ，２１８ｂを形成する。

【００２６】その後Ａ面の全面にパーマロイ膜２２０（ニッケルと鉄の合金）を例えば３００オングストローム程薄く真空蒸着により成膜する（図９（ｇ））。

【００２７】次に上記Ａ面の全面のパーマロイ膜２２０上に真空蒸着によりレジスト２２１を成膜する。上記レジスト２２１を密着露光により上記電磁式マグネット１０２ａ，１０２ｂの接触面のふちどった形で吸着部枠２２３ａ，２２３ｂを形成する。その後、上記Ａ面のレジスト２２１を除いて厚くパーマロイ膜２２２を例えば１２ミクロン程度均等に真空蒸着により成膜する（図１０（ｈ））。

【００２８】尚このパーマロイ膜２２０，２２２は例えば、

$NiSO_4 \cdot 6H_2O$（硫酸ニッケル）	・・・１５０ｇ
$FeSO_4 \cdot 7H_2O$（硫酸鉄）	・・・・・・・１０ｇ
H_3BO_4（硼酸）	・・・・・・・２０ｇ
サッカリン	・・・・・０．７５ｇ

を混合したものを用いる。

【００２９】次にこのＡ面上に形成された吸着部枠２２３ａ，２２３ｂのレジスト２２１をレジスト２２４ａ，２２４ｂで覆い、その後、例えば硝酸、過酸化水素水、水が２．９：１：７．２のエッチング液によりＡ面の吸着部枠外のパーマロイ膜２２０，２２２をエッチングして除去する（図１０（ｉ））。

【００３０】次にこのＡ面のレジスト２２１，２２４ａ，２２４ｂを密着露光によりすべて除去して吸着部２２３ａ，２２３ｂを形成する（図１０（ｊ））。そしてＡ面のＳｉ$O_2$２１０ａにコ字が対向した形状にエッチングを行い、最後に例えば水酸化カリウム溶液により所定の量だけエッチングを行なって可動片２０８ａ，２０８ｂが枢支部２２５を介して周囲枠に接続した形に形成する（図１０（ｋ））。上記のように加工されたＳｉ基板側２０９はセラミック基板側１０１とスペーサ１１９を介し接着する。

【００３１】次に第２の実施例の電磁式リレーの動作について説明する。電磁式マグネット１０２ａのコイル１０４ａに直流電圧を印加すると、この電磁式マグネット１０２ａに起磁力が生起し、可動片２０８の前片部２０

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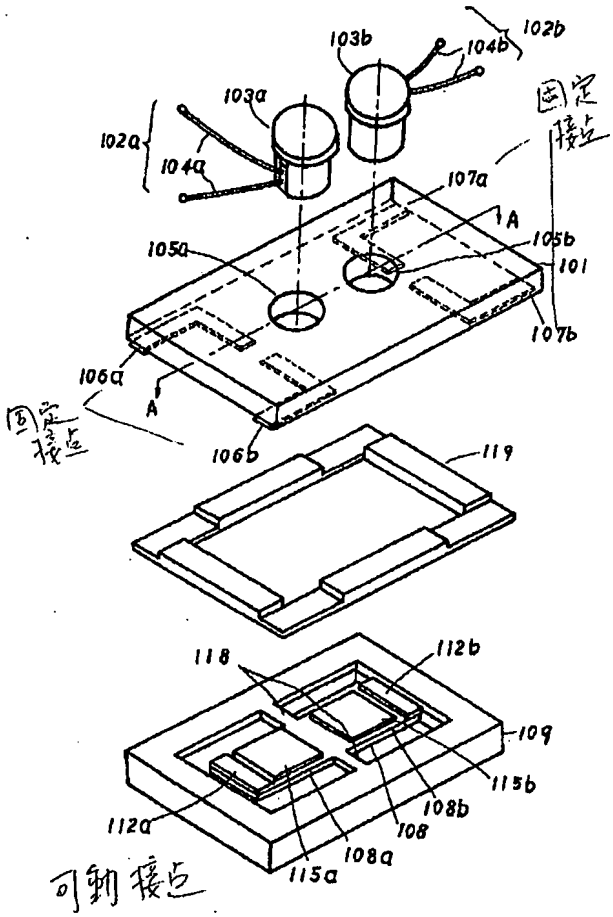
１０５ａ，１０５ｂ　貫通穴
１０６ａ，１０６ｂ　固定接点層
１０７ａ，１０７ｂ　固定接点層
１０８ａ，１０８ｂ　可動片
１０９　　Ｓｉ基板

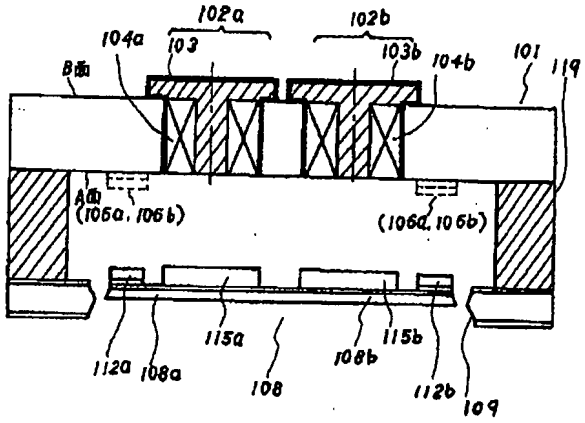
10

＊１１０ａ，１１０ｂ　SiO_2（酸化シリコン）
１１２ａ，１１２ｂ　可動接点層
１１５ａ，１１５ｂ　吸着部（磁性体）
１１８　　枢支部
＊　１１９　　スペーサ

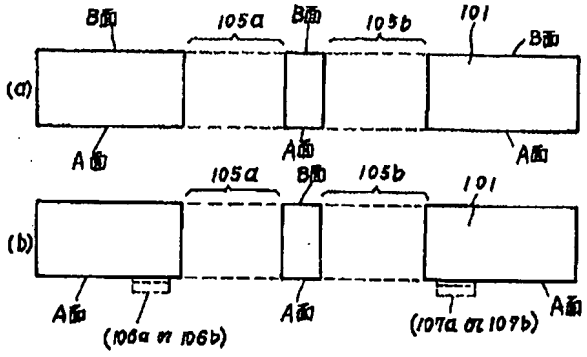
【図１】



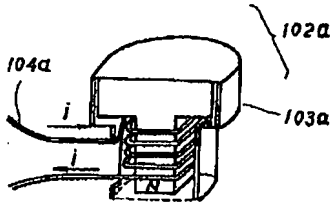
【図２】



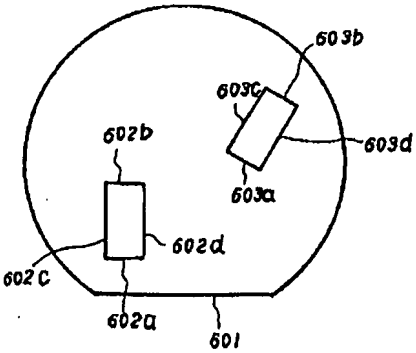
【図３】



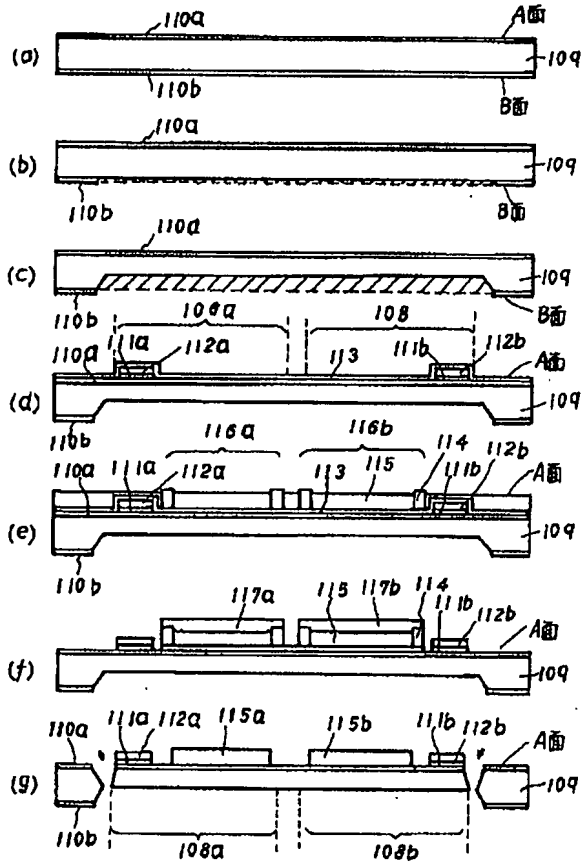
【図４】



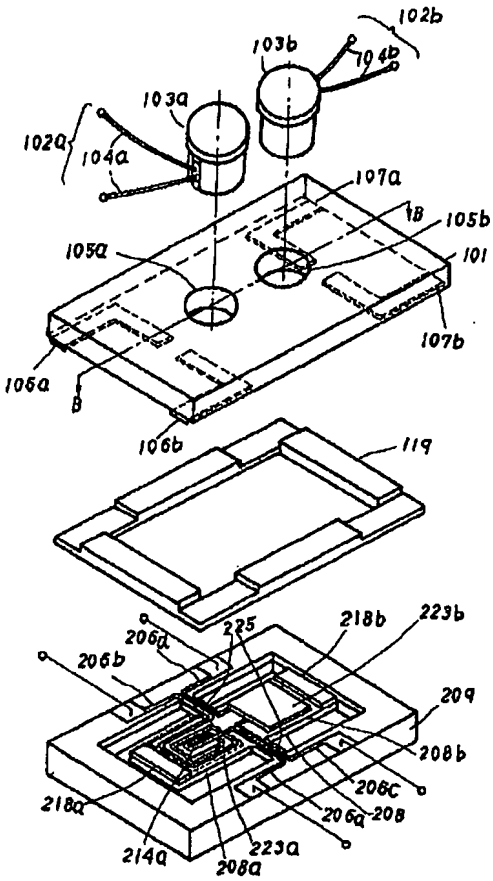
【図６】



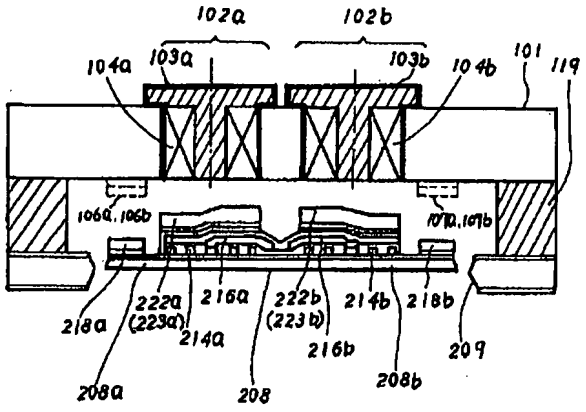
【図５】


(a)
(b)
(c)
(d)
(e)
(f)
(g)
A面
B面
109
110a
110b
111a
111b
112a
112b
113
114
115
115a
115b
116a
116b
117a
117b
108
108a
108b

【図７】


102a
102b
103a
103b
104a
104b
105a
105b
106a
106b
107a
107b
101
119
206a
206b
206c
208
208a
208b
209
214a
218a
218b
223a
223b
225

【図８】


102a
102b
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218a
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(223a)
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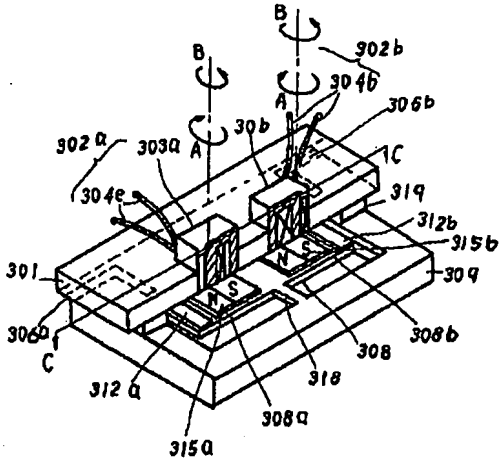
(223b)
216b
214b
218b
208a
208
208b
209

【図１１】


B
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302a
303a
A
305b
C
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312b
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301
N
S
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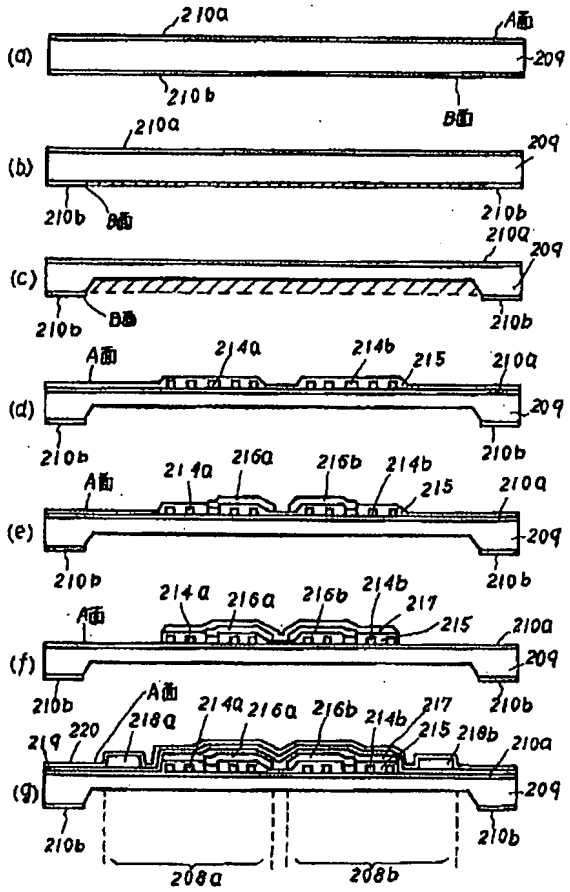
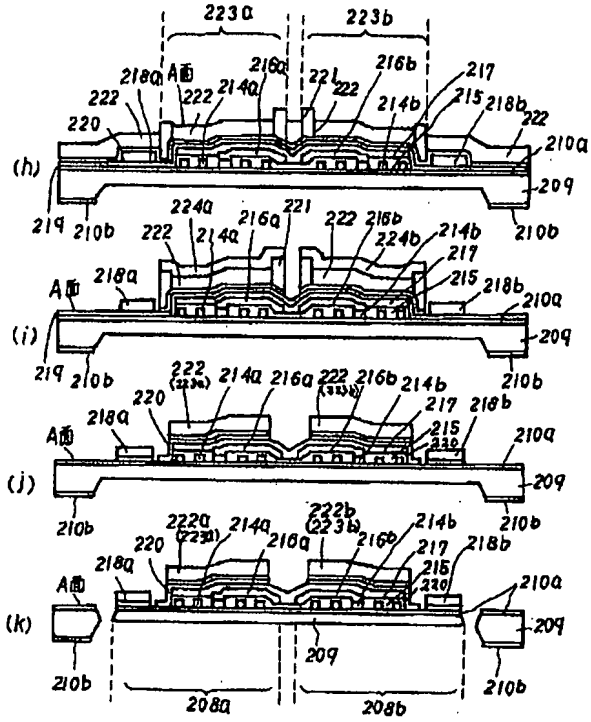
308
308b
312a
318
308a
315a

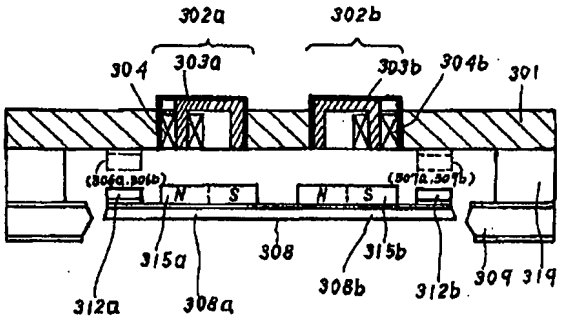
【図９】



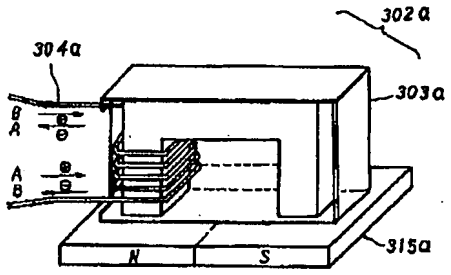
【図１０】



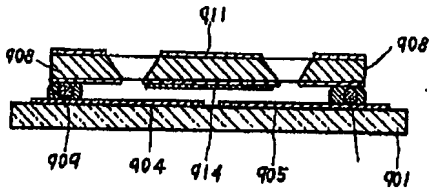
【図１２】



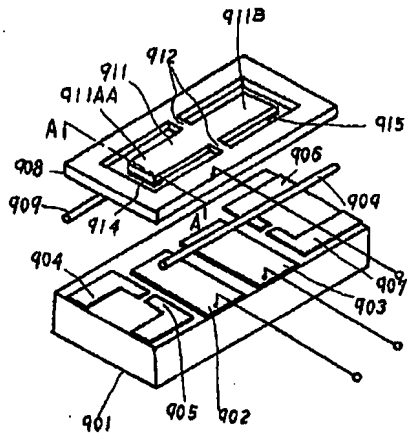
【図１３】



【図１５】



【図１４】



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